Subsidence in the Sept Iles layered intrusion (Canada) revealed by anisotropy of magnetic susceptibility

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ABSTRACT

The Sept Iles layered intrusion (Quebec, Canada) is an Ediacaran (564 Ma), dinner-plate shaped plutonic body with a diameter of 80 km and a maximum thickness of 7 km. It is the third largest layered intrusion in the world, after the Bushveld complex and the Dufek intrusion. From base to top, the Sept Iles intrusion is made up of a Layered Series (at least 4800 m thick) dominated by troctolite and gabbro, an anorthositic Upper Border Series and a broadly granitic Upper Series. About 90% of the intrusion is covered by the St. Lawrence River and only its northwesternmost portion is partly visible on the mainland and on islands.

We have conducted a structural study of the outcropping part of the Layered Series, using the technique of low-field anisotropy of magnetic susceptibility. The bulk magnetic susceptibility (values from 5 to 280×10^{-3} SI, excluding one strongly altered sample) is largely ferromagnetic and dominated by magnetite. The magnetic fabrics can be divided into three categories (Type 1 to 3), according to the orientation of magnetic foliation (K_1-K_2 plane) and magnetic lineation (K_1 axis). In Type 1 (67% of the samples), the magnetic foliation is at low angle to the igneous layering (that consistently shows centripetal, relatively low dips) and the magnetic lineation is gently plunging, towards the SE in average. Type 2 (25% of the samples) is also characterized by a magnetic foliation that approximates layering and a lineation that is gently-plunging, however the latter is inclined to the NE in average. In type 3 (9% of the samples), the magnetic foliation is steeply-dipping and the magnetic lineation is of variable orientation. Type 1 is interpreted as a "normal" magnetic fabric, controlled by the shape anisotropy of large (i.e. multidomain) magnetite grains. Type 2 would be an "intermediate" magnetic fabric, with a switching of the K_1 and K_2 axes due to some interference between the normal magnetic fabric and an "inverse" fabric linked to numerous, very small (i.e. single-domain) magnetite inclusions identified in silicates. Type 3 would be either an intermediate magnetic fabric reflecting a stronger influence of the minute inclusions of magnetite or a secondary fabric.

The average magnetic lineation of Type 1 (orientation of 141SE10) is inclined inwards, toward the deepest part of the Sept Iles intrusion coinciding with a maximum of the gravity anomaly that delimits the plutonic body. This is interpreted as an evidence of stretching of the cumulate rocks recorded during foundering of the Fe-Ti-oxide-rich, high-density Layered Series into lower-density country-rocks (quartz-feldspath-rich Grenvillian gneisses). Such a "central subsidence" has been evidenced in other mafic to ultramafic layered intrusions (e.g. the Skaergaard intrusion, the Bjerkreim-Sokndal intrusion and the Rum layered suite). It was possibly triggered here by very high thermal conditions, since it has been suggested elsewhere that the Sept Iles intrusion might be related to an important mantle plume.

Key words: cumulate; magnetite; normal magnetic fabric; intermediate magnetic fabric; inverse magnetic fabric; density contrast.

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